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INTERIM ENGINEERING LETTER

ON

TRANSMITTER-RECEIVER PROJECT

Assigned

50X1

ILLEGIB

Letter No. 1

Covering the Period
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PURPOSE OF PROJECT

a. Investigate possible new circuits which will improve the performance or simplify the construction of transistor radio receivers.

b. Investigate ways in which the reliability of transistor circuits can be improved by reducing the effects of variations between components and by compensating for the effects of temperature.

c. Investigate new types or improved variations of transistors as they become available to determine their applicability to radio receivers or transmitters.

PROJECT STATUS

a. AGC applied to the bases of the transistors was investigated. This method offers increased sensitivity of control over AGC applied to the emitters as in the experimental receiver. The unbalanced gain reduction that generally accompanies this type of circuit was reduced to a satisfactory value.

b. Several new type transistors were measured to determine their applicability to radio receivers. The results were:

	Power Gain	
Transistor	455 Kc	4 mc
Texas Instrument #904 (silicon)	24db.	5 db.
Philco Surface Barrier	28db.	16 db.

DETAILS OF WORK DONE THIS PERIOD

AGC System

The AGC in the experimental receiver is applied to the emitters of the first and second i-f amplifiers. Since current amplification is present in these amplifiers, more sensitive AGC is available by applying AGC control to the bases of the transistors. A new AGC system was built and tested. The schematic of the circuit is shown in Figure 2. For comparison the schematic of the original circuit where AGC is applied to the emitters is shown in Figure 1. As is seen in Fig. 2 the AGC amplifier is now operating as a grounded emitter-base input stage. AGC is applied to the first and second i-f amplifiers through R_1, R_2, R_3 and R_4. These resistors are 1000 ohms each, making up a total of 2000 ohms series resistance to each

amplifier as compared to 120 ohms for R_1 and R_2 in the original circuit. C_3 and C_4 are used to filter out the audio signal serving the same function as C_1 and C_2 in the original circuit. The AGC characteristic of both systems is plotted in Fig. 3. With the new system the control is a 2.5 db. change in output for 50 db. increase in input. While with the old system the control is 2 db. variation in output for 34 db. increase in input. The difference in the basic output level between the two systems is due to the higher gain in the common-emitter AGC/audio amplifier that is used in the new system.

Because the series resistors R_1, R_2, R_3 and R_4, are large, better balancing of AGC action when applied to two dissimilar i-f transistors is obtained. Two transistors were put in the first and second i-f stages. They had (a) first stage - I_{co} = 79 µa and voltage gain = 14 db; and (b) second stage - I_{co} = 380 µa and voltage gain = 28 db. As can be seen from Figure 4, the new system of AGC provides as good or better balance of gain reduction than the earlier system.

New Transistors

1. Eight Texas Instrument, type 904 silicon, grown-junction, NPN transistors were evaluated for power gain, input resistance and output impedance as functions of frequency. V_c and I_e were +5v. and -1 ma. respectively. Maximum, median and minimum values are plotted in Figure 5. Power gain was measured with the transistors operating in the common emitter stages. The input was resistance matched and output conjugate matched. These transistors compare quite favorably with SX160's. The power gain is about equivalent. The input resistance is much higher and the output resistance lower with the 904's than the SX160's. Except for one unit, the characteristics of the 904's are quite consistent from unit to unit. The one unit shows on the curves as having maximum input resistance and minimum power gain and output resistance. The output capacitance is about 10 to 25 µµf.

2. A Philco surface-barrier transistor was measured for power gain, input and output resistances for frequency up to 8 mc. V_c and I_e were -3v. and -0.5 ma., respectively. The setup was the same as that used in measuring the Texas Instruments 904's. The results are shown in Figure 6. The surface-barrier transistor shows higher power gain - 28 db. at 455 Kc and reasonably good frequency response - 11 db. power gain at 8 mc. As in the case of the Texas Instruments 904's the surface-barrier transistor has a higher input resistance and lower output resistance than the SX160's.
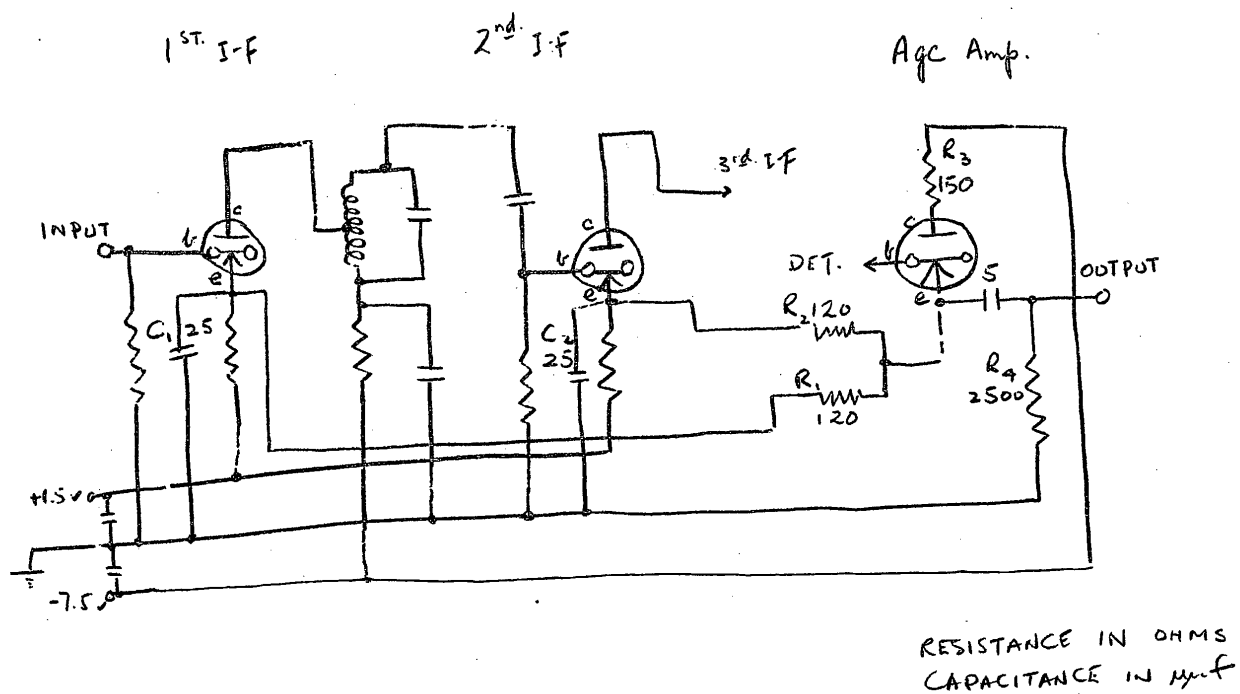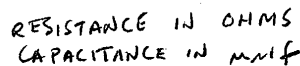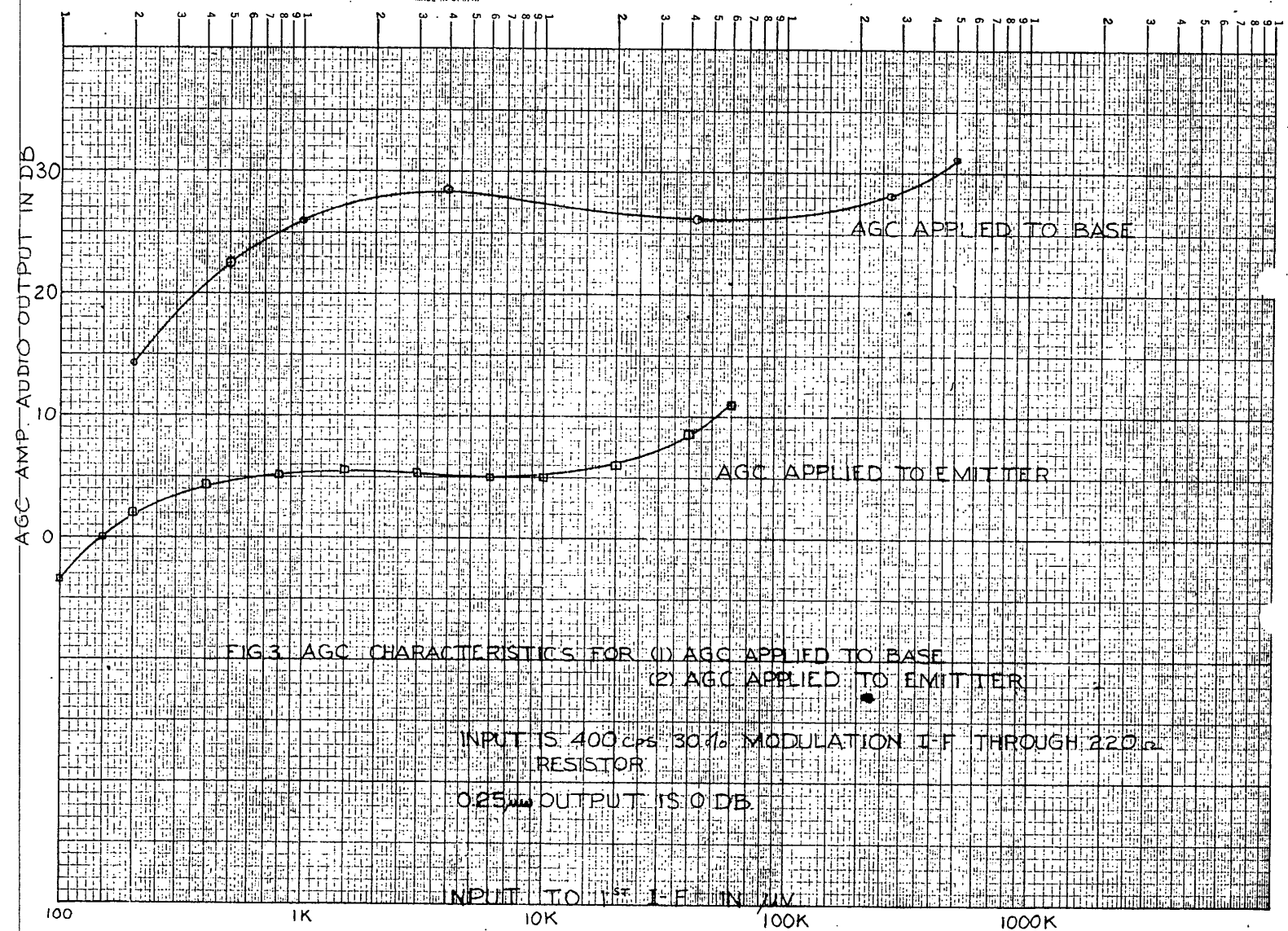
FIG. I. AGC APPLIED TO EMITTER
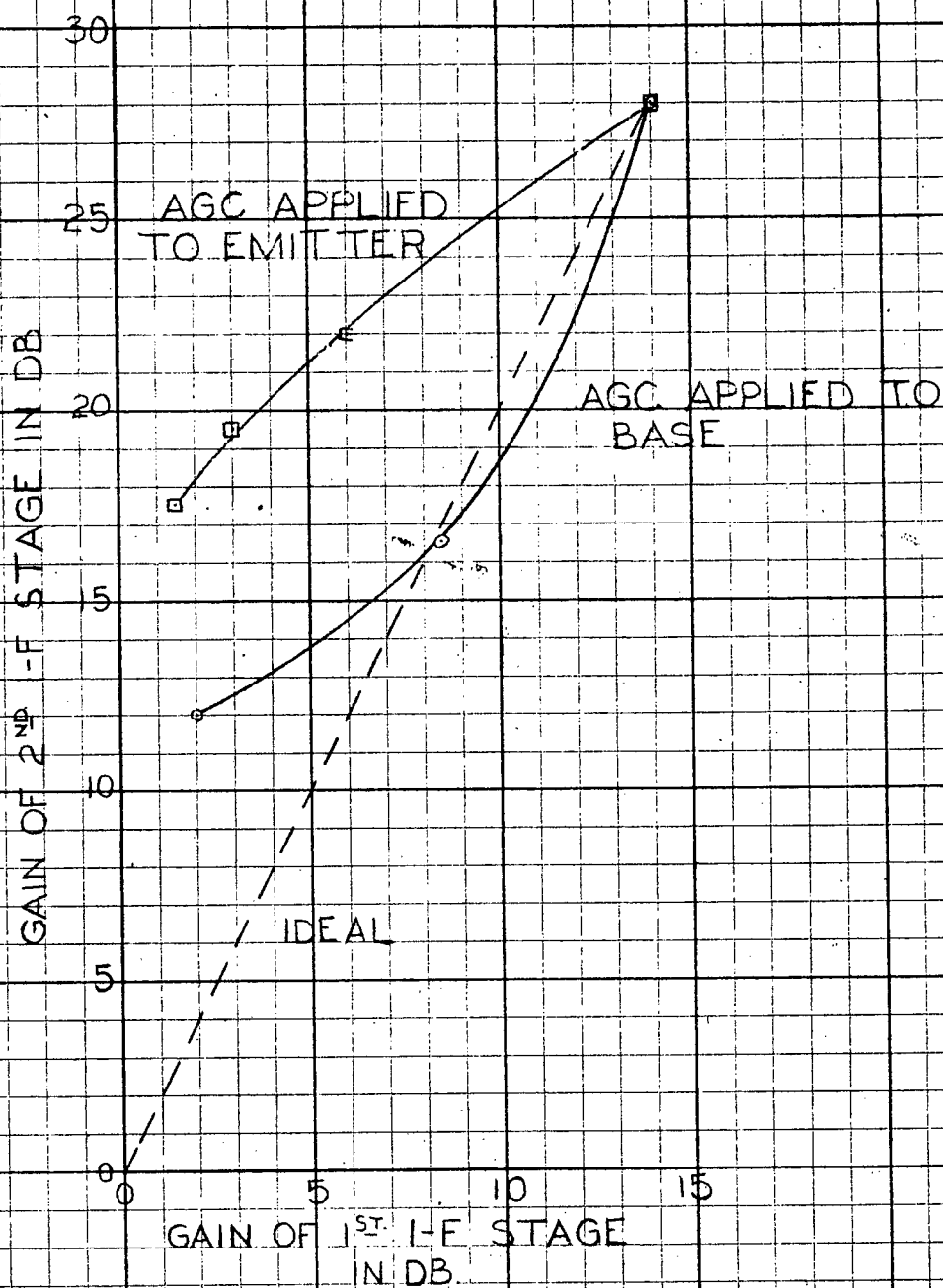
FIG. 2. AGC APPLIED TO BASE

359-91   KEUFFEL & ESSER CO.
MADE IN U.S.A.

FIG 3. AGC CHARACTERISTICS FOR (1) AGC APPLIED TO BASE
(2) AGC APPLIED TO EMITTER

INPUT IS 400 cps 30% MODULATION I-F THROUGH 220 Ω RESISTOR

0.25 µw OUTPUT IS 0 DB

AGC APPLIED TO BASE

AGC APPLIED TO EMITTER

INPUT TO 1ST I-F IN µV
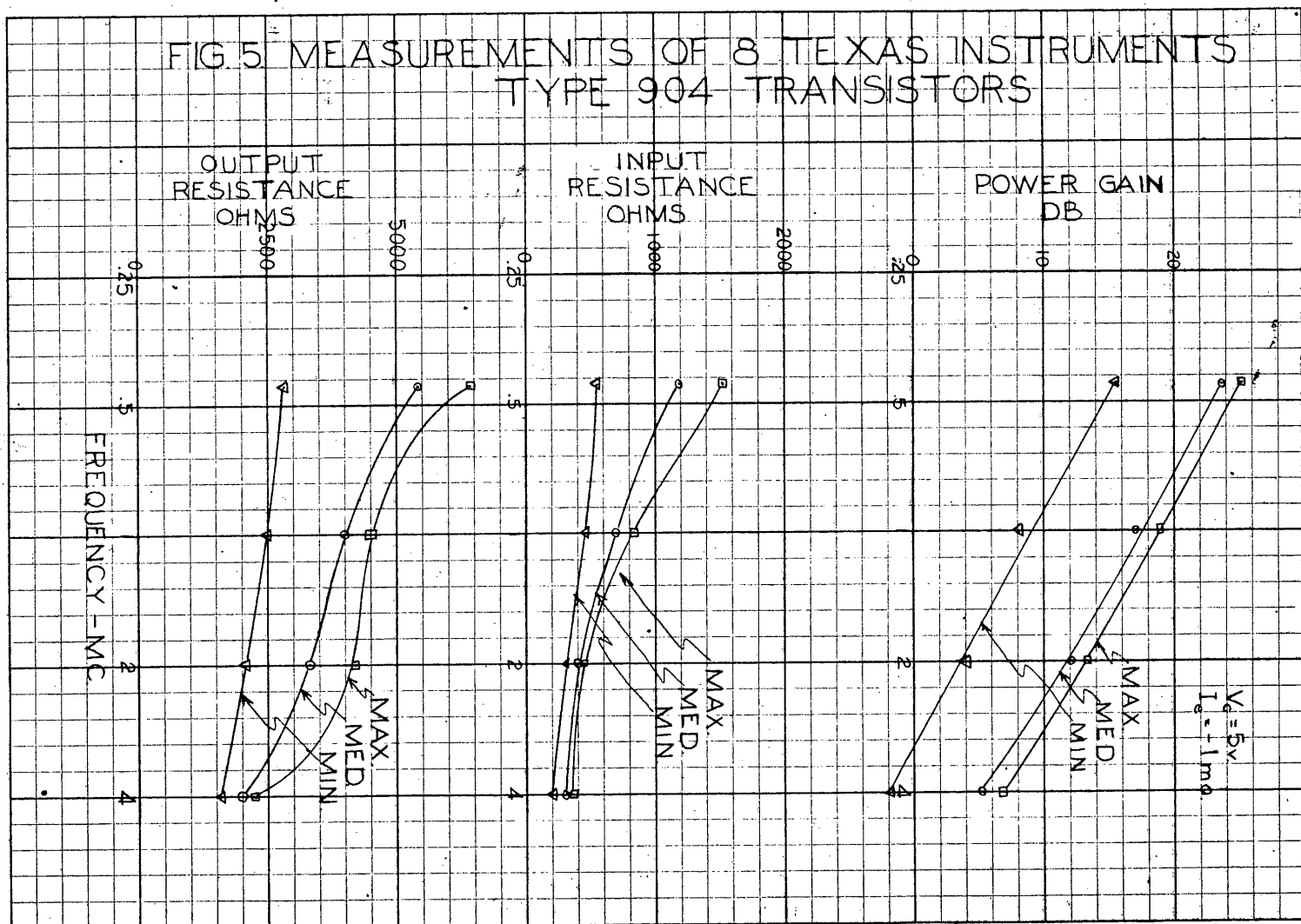
FIG. 4   COMPARISON OF THE BALANCING OF TWO AGC SYSTEMS WHEN APPLIED TO DISSIMILAR TRANSISTORS

TRANSISTOR	I_{co}	VOLTAGE GAIN
1ST STAGE	79 μa	14 db
2ND STAGE	380 μa	28 db

5 × 5 to the inch.
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FIG 5 MEASUREMENTS OF 8 TEXAS INSTRUMENTS
TYPE 904 TRANSISTORS

FIG 6 MEASUREMENTS OF A PHILCO SURFACE-
BARRIER TRANSISTOR